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FCC TEST REPORT

Under

FCC 15 Subpart C, Paragraph 15.247

Operation within the bands 902- 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz

☒DTS - Digital Transmission System ☒Single Modular

Prepared For :

Appion Incorporated

2800 South Tejon Street Englewood, CO 80110

FCC ID: 2ABH9-LR2188
EUT: LR2188
Model: LR2188, LR2188-uFL

August 5, 2019 **Issue Date:**
Original Report **Report Type:**
 **Test Engineer:** Jacky Huang
 **Review By:** Apollo Liu / Manager

Table of Contents

Report Revision History

Report #	Version	Description	Issued Date
KSZ2019121203J01	Rev.01	Initial issue of report	May 10, 2019
KSZ2019121203J01	Rev.02	Update section 1.6 & 7.1 of report	July 19, 2019
KSZ2019121203J01	Rev.03	Update section 1.6 of report	August 5, 2019

1. General Information

1. 1 Notes

The test results of this report relate exclusively to the test item specified in 1.6. The KMO Lab does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of the KMO Lab.

1. 2 Testing Laboratory

Test Firm Name:	**Ke Mei Ou Lab Co., Ltd.**
Test Firm Address:	2013-2016, 20th Floor, Business Center, Jiahui Xin Cheng, No 3027, Shen Nan Road, Fu Tian, Shen Zhen, Guang Dong, P. R. China
FCC Designation Number:	CN1532
Test Firm Registration Number:	344480
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ANSI-ASQ National Accreditation Board/ACLASS ISO/IEC 17025 Accredited Lab for telecommunication standards. The Registration Number is AT-1532. The testing quality system meets with ISO/IEC-17025 requirements, This approval results is accepted by MRA of ILAC.	

1. 3 Detai1. 3 Details of Applicant

Name: **Appion Incorporated**
Address: **2800 South Tejon Street Englewood, CO 80110**

1. 4 Application Details

Date of Receipt of Application : December 12, 2018
Date of Receipt of Test Item : March 25, 2019
Date of Test : March 25~May 10, 2019

1. 5 Details of Manufacturer

Name: **Appion Incorporated**
Address: **2800 South Tejon Street Englewood, CO 80110**

1. 6 Test Item

EUT Feature	
EUT Description:	LR2188
Brand Name:	Appion
Model Name:	LR2188, LR2188-uFL
EUT RF Technology:	☐Bluetooth v3.0 + EDR ☐Bluetooth v4.0 LE ☒Bluetooth v4.2 LE ☐Bluetooth v5.0 LE ☐WLAN 2.4GHz 802.11b/g/n HT/20/40 ☐WLAN 5GHz 802.11a/n HT20/HT40 ☐WLAN 5GHz 802.11ac VHT20/VHT40/VHT80
HW Version:	V1.2.4
SW Version:	V1.2.4
EUT Stage:	Identical Prototype
Note: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.	

Additional Information

Standard Product Specification				
Tx/Rx Frequency Range	2402~2480 MHz			
Number of Channels	40 (37 hopping + 3 advertising channel)			
Carrier Frequency of Each Channel	f=2402+k MHz (k=0,2,4…,39)			
Antenna Type / Gain	Chain Number	Antenna Gain	Internal	External
	0	1.3dBi	☒Chip ☐PIFA	☐Dipole ☐Whip
	0	4.9dBi	☐Chip ☐PIFA	☒Dipole ☐Whip
	0	3.0dBi	☐Chip ☐PIFA	☐Dipole ☒Whip
Type of Modulation	Bluetooth LE : GFSK			
EUT Operational Condition	☐ AC			
	☒ DC → ☐ From Battery ☐ External AC adapter ☐ POE			
	☒ DC Power 3.3Vdc			

1. 7Applicable Standards

Applicable Standards
According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards: FCC Part 15 Subpart C 15.247 FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02 FCC KDB 414788 D01 Radiated Test Site v01r01 ANSI C63.10-2013
Note: 1) All test items were verified and recorded according to the standards and without any deviation during the test. 2) This EUT has also been tested and complied with the requirements of FCC 15 Part 15, Subpart B, recorded in a separate test report.

2. Technical Test

2. 1 Summary of Test Results

The EUT has been tested according to the following specifications:

FCC Rules	Test Type	Limit	Result	Notes
15.247(a)(2)	6dB Bandwidth	≥0.5MHz	PASS	Complies.
-	99% Bandwidth	-	PASS	Complies.
15.247(b)(3)	Peak Output Power	≤ 30dBm	PASS	Complies.
15.247(e)	Power Spectral Density	≤8dBm/3kHz	PASS	Complies.
15.247(d)	Conducted Band Edges and Spurious Emission	≤20dBc	PASS	Complies.
15.247(d)	Radiated Band Edges and Spurious Emission	FCC 15.209(a) & 15.247(d)	PASS	Complies
15.247(d)	Conducted Band Edges and Spurious Emission	≤ 20dBc	PASS	Complies
15.207	AC Conducted Emission	FCC15.207(a)	PASS	Complies
15.203 & 15.247(b)	Antenna Requirement	N/A	PASS	Complies
15.247(i) & 1.1307(b)(1) & 2.1091	Maximum Permissible Exposure (MPE)	< 1mW/cm^2	PASS	Complies

2. 2Antenna Requirement

A. Regulation

Per § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

B. Result

*Internal antenna version: The EUT uses a SMT chip antenna that is soldered and permanently attached onto the PCB.
*External antenna version: The EUT has a provision for connection to an external antenna, using a unique U.FL connector, and was tested with a dipole, Whip antennas provided by applicant. No other external antennas are to be used with EUT.
The dipole antenna will be equipped with unique RP-SMA connector. RF cables with unique RP-SMA and U.FL connector will used to provide connector between antenna and module.
Therefore the EUT complies with Section 15.203 of the FCC rules.

2. 3 Measurement Uncertainty

Measurement	Frequency	Uncertainty
Conducted emissions	0.15MHz~30MHz	1.72
Radiated emissions	30MHz ~ 300MHz	3.88
Radiated emissions	300MHz ~1000MHz	3.86
Radiated emissions	>1000MHz	4.42
Bandwidth	-	5%
Peak Power	-	1.10
Peak Power Spectral Density	-	1.10
Band Edges Measurement	-	1.10

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

3. EUT Modifications

No modification by test lab.

4. Conducted Power Line Test

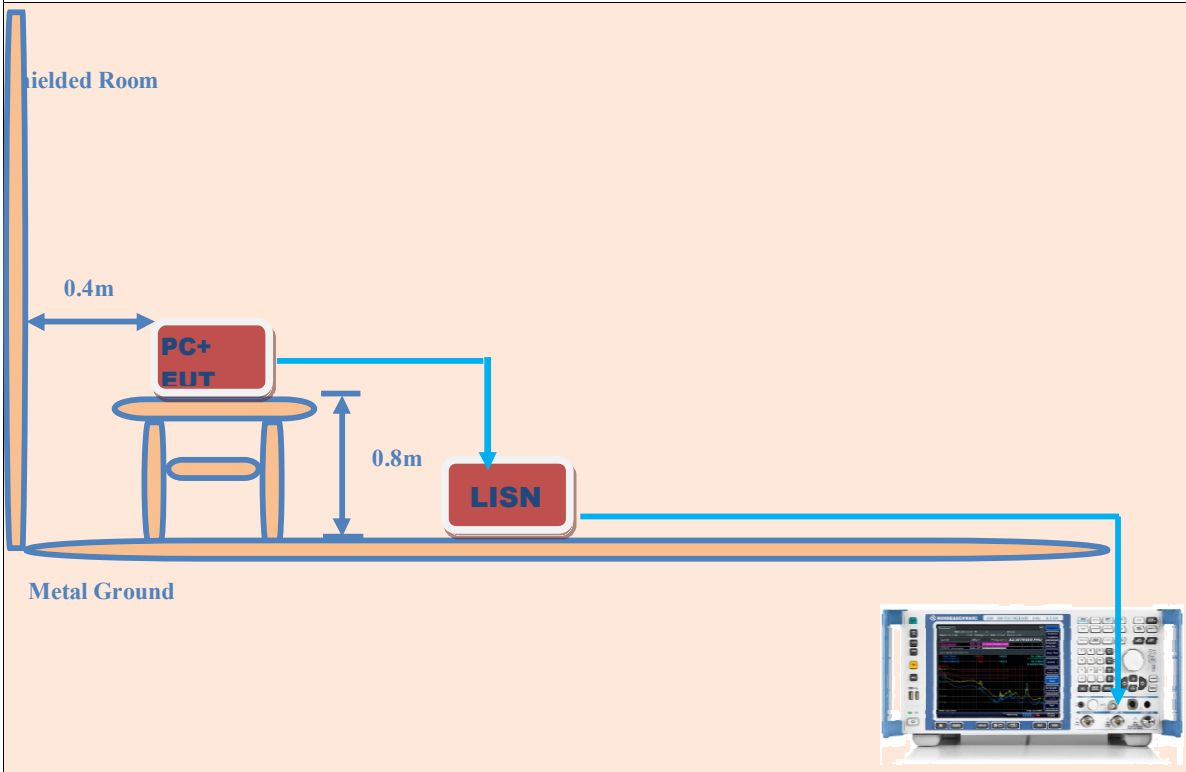
4. 1 Test Equipment

Please refer to Section 10 this report.

4. 2 Test Procedure

Test Method	
☒	The EUT and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50 ohm/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission., the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10:2013 on conducted measurement. Conducted emissions were invested over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9kHz.

4. 3 Test Setup

Test Setup
AC Line Conducted Emissions

This test is applicable for radio equipment and/or ancillary equipment for fixed use powered by the AC mains. This test shall be performed on a representative configuration of the radio equipment, the associated ancillary equipment, or a representative configuration of the combination of radio and ancillary equipment. This test assesses the level of internally generated electrical noise present on the AC power input/output ports.

4. 4 Configuration of the EUT

Description of Bluetooth LE Test Mode

Channel	Frequency (MHz)	Bluetooth RF Output Power Data Rate / Modulation					
		GFSK					
		Chip Antenna		Dipole Antenna		Whip Antenna	
CH00	2402	-4.53	dBm	-4.39	dBm	-3.96	dBm
CH19	2440	-3.24	dBm	-3.11	dBm	-2.76	dBm
CH39	2480	-1.89	dBm	-1.69	dBm	-1.45	dBm

Bluetooth Test Mode

The following summary table is showing all test modes to demonstrate in compliance with the standard.

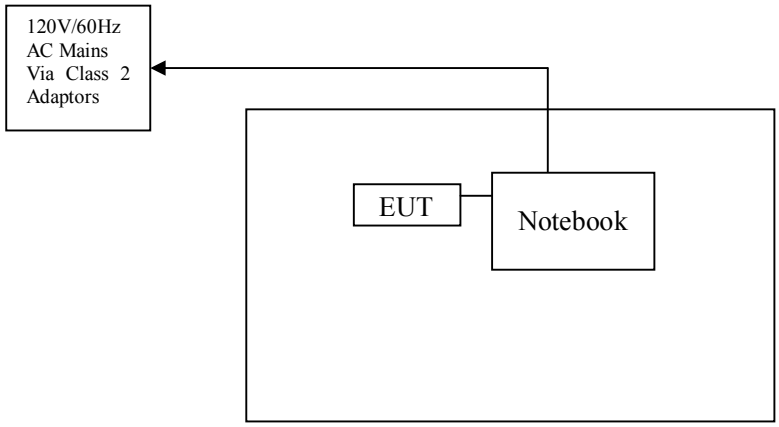
Summary Tables of Test Mode	
Test Item	Data Rate / Modulation
	BT LE / 1Mbps GFSK
Conducted Cases	Mode 1: CH00_2402 MHz Mode 2: CH19_2440 MHz Mode 3: CH39_2480 MHz
Radiated Cases	Mode 1: CH00_2402 MHz Mode 2: CH19_2440 MHz Mode 3: CH39_2480 MHz
AC Conducted Emission	Test Mode: Bluetooth Link with Controller(DC Power)
Note: 1) The worst case of conducted emission is test mode 2 with dipole; only the worst case was reported. 2) For Radiated case, The tests were performed with Chip / Dipole / Whip antenna.	

EUT Operation Test Setup	
Pre-Scan has been conducted to determine the worst-case mode from all possible combinations. Only the worst test mode data was reported. For Bluetooth function, the engineering test program was provided and enabled to make EUT connect with Bluetooth base station to continuous transmit/receive. For AC power line conducted emissions, the EUT was set to connect with the PC host under large package sizes transmission.	
Pre-Scan Mode	
Test Mode	**Operating Description**
1	EUT with Chip Antenna
2	EUT with Dipole Antenna
3	EUT with Whip Antenna
Conducted Emissions → Final	
Test Mode	**Operating Description**
1	EUT with Chip Antenna
2	EUT with Dipole Antenna
3	EUT with Whip Antenna
AC Conducted Emissions → Final	
2	EUT with Dipole Antenna
Radiated Emissions → Final	
Test Mode	Operating Description
1	EUT with Chip Antenna
2	EUT with Dipole Antenna
3	EUT with Whip Antenna
Note: The test modes were carried out for all operation modes (include link and idle). The final test mode of the EUT was the worst test mode for Mode 1, and its test data was reported.	

Support Unit				
Device	**Manufacturer**	**Model # Serial #**	**FCC ID/ DoC**	**Cable**
Notebook	LENOVO	20195	DoC	1.5m unshielded power cord
Test Board	Embeddedmasters	EM-WSEP-ARD	-	-

4. 5 EUT Operating Condition

Operating condition is according to ANSI C63.10:2013.
a. Setup the EUT and simulators as shown on follow.
b. Enable RF signal and confirm EUT active.
c. Modulate output capacity of EUT up to specification.



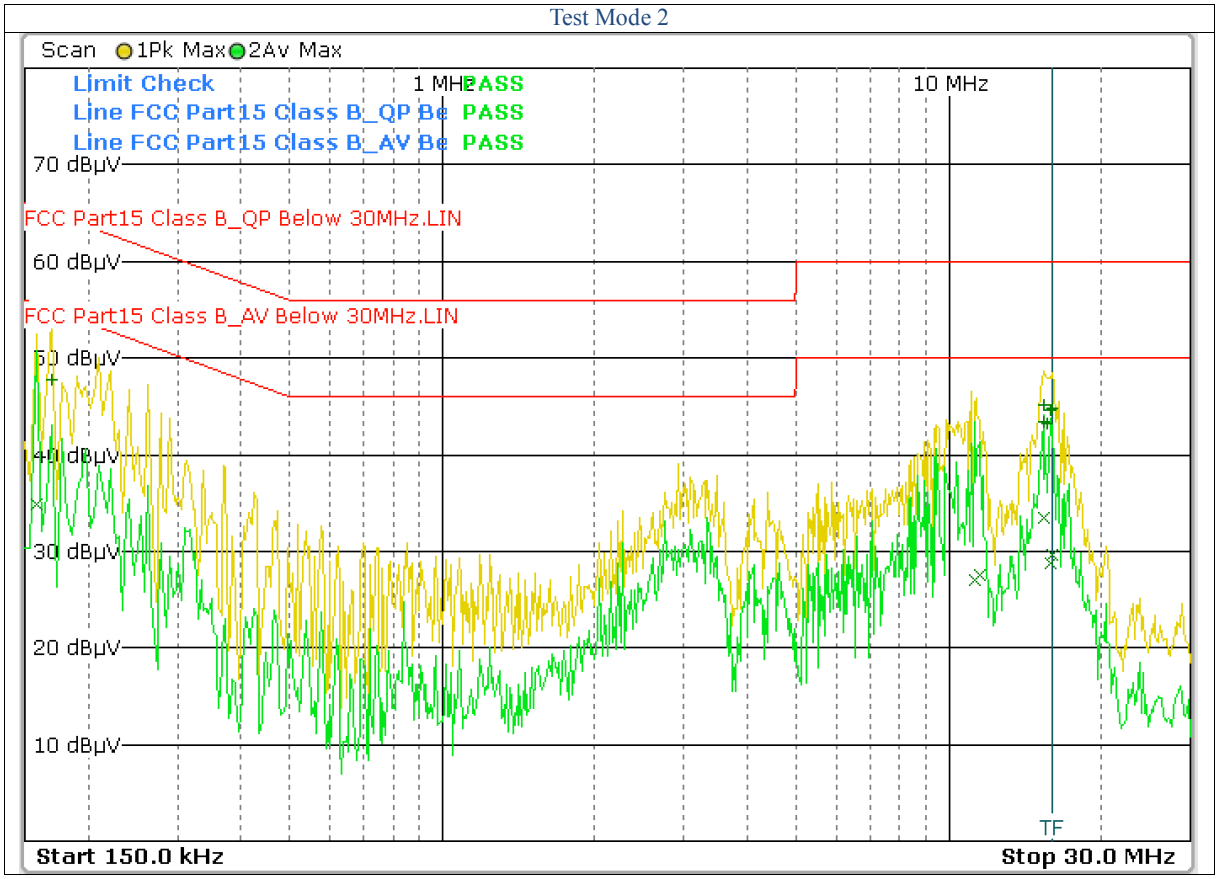
4. 6 Conducted Power Line Emission Limits

FCC Part 15 Paragraph 15.207 (dBuV)	
Frequency Range (MHz)	**QP/AV**
0.15 – 0.5	66-56/56-46
0.5 – 5.0	56/46
5.0 - 30	60/50

Note: In the above table, the tighter limit applies at the band edges.

4. 7 Conducted Power Line Test Result

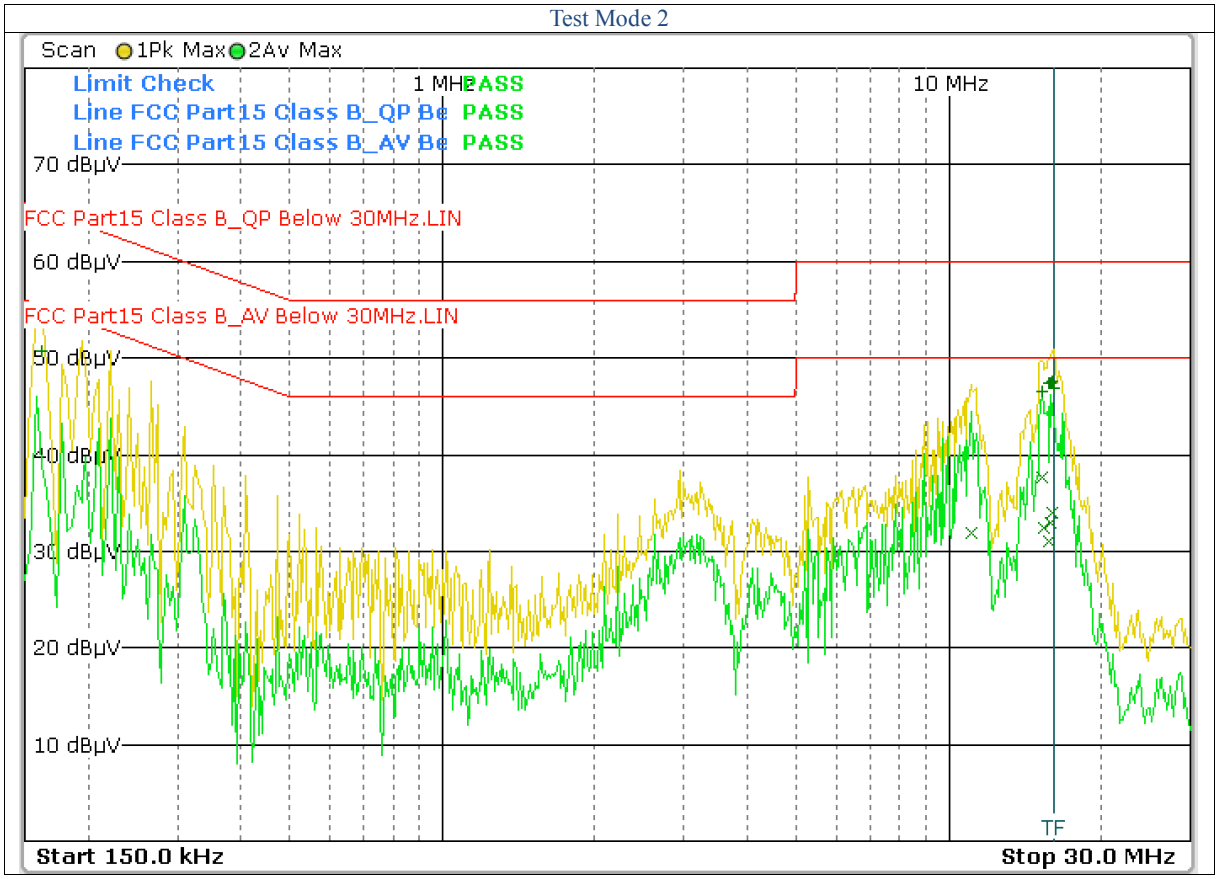
Test Mode 2



FCC15										
Frequency (MHz)	Read Level (dBuV)		Factor (dB)	Emission (dBuV)		Line/ Neutral	Limit (dBuV)		Margin(dBuV)	
	QP	AV		QP	AV		QP	AV	QP	AV
0.158	37.43	24.49	10.30	47.73	34.79	Line	65.57	55.57	-17.84	-20.78
11.266	32.46	16.20	10.80	43.26	27.00	Line	60.00	50.00	-16.74	-23.00
15.394	34.11	22.38	11.00	45.11	33.38	Line	60.00	50.00	-14.89	-16.62
15.462	32.42	17.72	10.90	43.32	28.62	Line	60.00	50.00	-16.68	-21.38
15.866	33.69	17.80	11.00	44.69	28.80	Line	60.00	50.00	-15.31	-21.20
15.986	33.89	18.71	10.90	44.79	29.61	Line	60.00	50.00	-15.21	-20.39
FCC15										

Note:
1.Uncertainty in conducted emission measured is <+/ -2dB.
2.The emission levels of other frequencies were very low against the limit.
3.All Reading Levels are Quasi-Peak and Average value.
4.Emission = Meter Reading + Factor; Factor = Insertion Loss + Cable Loss.
5.Margin Value= Emission Level - Limit Value.

Test Mode 2



FCC15										
Frequency (MHz)	Read Level (dBuV) QP	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV) QP	Emission (dBuV) AV	Line/ Neutral	Limit (dBuV) QP	Limit (dBuV) AV	Margin(dBuV) QP	Margin(dBuV) AV
11.082	36.50	21.64	10.30	46.80	31.94	Neutral	60.00	50.00	-13.20	-18.06
15.278	35.77	26.77	10.80	46.57	37.57	Neutral	60.00	50.00	-13.43	-12.43
15.406	36.34	21.48	11.00	47.34	32.48	Neutral	60.00	50.00	-12.66	-17.52
15.814	36.44	20.12	10.90	47.34	31.02	Neutral	60.00	50.00	-12.66	-18.98
15.930	36.40	21.89	11.00	47.40	32.89	Neutral	60.00	50.00	-12.60	-17.11
16.054	36.74	23.12	10.90	47.64	34.02	Neutral	60.00	50.00	-12.36	-15.98
FCC15										

Note:
1.Uncertainty in conducted emission measured is <+/ -2dB.
2.The emission levels of other frequencies were very low against the limit.
3.All Reading Levels are Quasi-Peak and Average value.
4.Emission = Meter Reading + Factor; Factor = Insertion Loss + Cable Loss.
5.Margin Value= Emission Level - Limit Value.

5. FCC Part 15.247 Requirements for DTS Systems

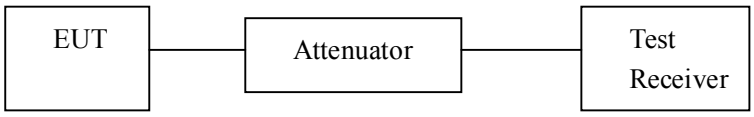
5. 1 Test Equipment

Please refer to Section 10 this report.

5. 2 Test Procedure

6 dB & 99% Bandwidth	Refer to FCC 15.247(a)(2), ANSI C63.10:2013	
Test Method:	FCC KDB Publication No.558074 D01 DTS Meas Guidance v05r02 – 8.2	
a) Set RBW = 100 kHz. b) Set the video bandwidth (VBW) ⩾ 3 x RBW. c) Detector = Peak. d) Trace mode = max hold. e) Sweep = auto couple. f) Allow the trace to stabilize.		g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission. *For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 30kHz and set the Video bandwidth (VBW) = 100kHz.
Peak Power:	Refer to FCC 15.247(b)(3), ANSI C63.10:2013	
Test Method:	FCC KDB Publication No.558074 D01 DTS Meas Guidance v05r02 – 8.3 PKPM1 Peak power meter method	
The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.		
Peak Power Spectral Density:	Refer to FCC 15.247(e), ANSI C63.10:2013	
Test Method:	FCC KDB Publication No.558074 D01 DTS Meas Guidance v05r02 – 8.4 Method PKPSD	
a) Set analyzer center frequency to DTS channel center frequency. b) Set the span to 1.5 times the DTS bandwidth. c) Set the RBW to: 3 kHz ⩽ RBW ⩽ 100 kHz. d) Set the VBW ⩾ 3 x RBW. e) Detector = peak. f) Sweep time = auto couple.		g) Trace mode = max hold. h) Allow trace to fully stabilize. i) Use the peak marker function to determine the maximum amplitude level within the RBW. j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
Band Edges Measurement:	Refer to FCC 15.247(d), ANSI C63.10:2013	
Test Method:	FCC KDB Publication No.558074 D01 DTS Meas Guidance v05r02 & 15.247	
a. The transmitter output was connected to the spectrum analyzer via a low lose cable. b. Set both RBW and VBW of spectrum analyzer to 100kHz with suitable frequency span including 100kHz bandwidth from band edge. c. The band edges was measured and recorded.		

5. 3 Test Setup



5. 4 Configuration of the EUT

Same as section 4.4 of this report

5. 5 EUT Operating Condition

Same as section 4.5 of this report.

5. 6 Limit

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902 ~ 928 MHz, 2400 ~ 2483.5 MHz, and 5725 ~ 5850 MHz bands. The minimum 6dB bandwidth shall beat least 500 kHz.
According to §15.247(b)(3), for systems using digital modulation in the bands of 902-928MHz, 2400-2483.5 MHz, and 5725-5850 MHz: 1 Watt.
According to §15.247(b)(4), the conducted output power limit specified in paragraph (b) ofthis section is based on the use of antennas with directional gains that do not exceed 6 dBi.Except as shown in paragraph (c) of this section, if transmitting antennas of directional gaingreater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, asappropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spreadspectrum intentional radiator in operating, the radio frequency power that is produced by theintentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band thatcontains the highest level of the desired power, based on either an RF conducted or a radiatedmeasurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a),must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)).
According to §15.247(e), for digitally modulated systems, the power spectral density conductedfrom the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz bandduring any time interval of continuous transmission.
According to §15.247(f), the digital modulation operation of the hybrid system, with thefrequency hopping turned off, shall comply with the power density requirements ofparagraph (d) of this section.

5. 7 Test Result

A. 6 dB Bandwidth

Refer to Appendix_DTS_BLE.

B. Peak Power

Refer to Appendix_DTS_BLE.

C. Band Edges Measurement

Refer to Appendix_DTS_BLE.

D. Peak Power Spectral Density

Refer to Appendix_DTS_BLE.

6. Transmitter Spurious Radiated Emission at 3 Meters

6. 1 Test Equipment

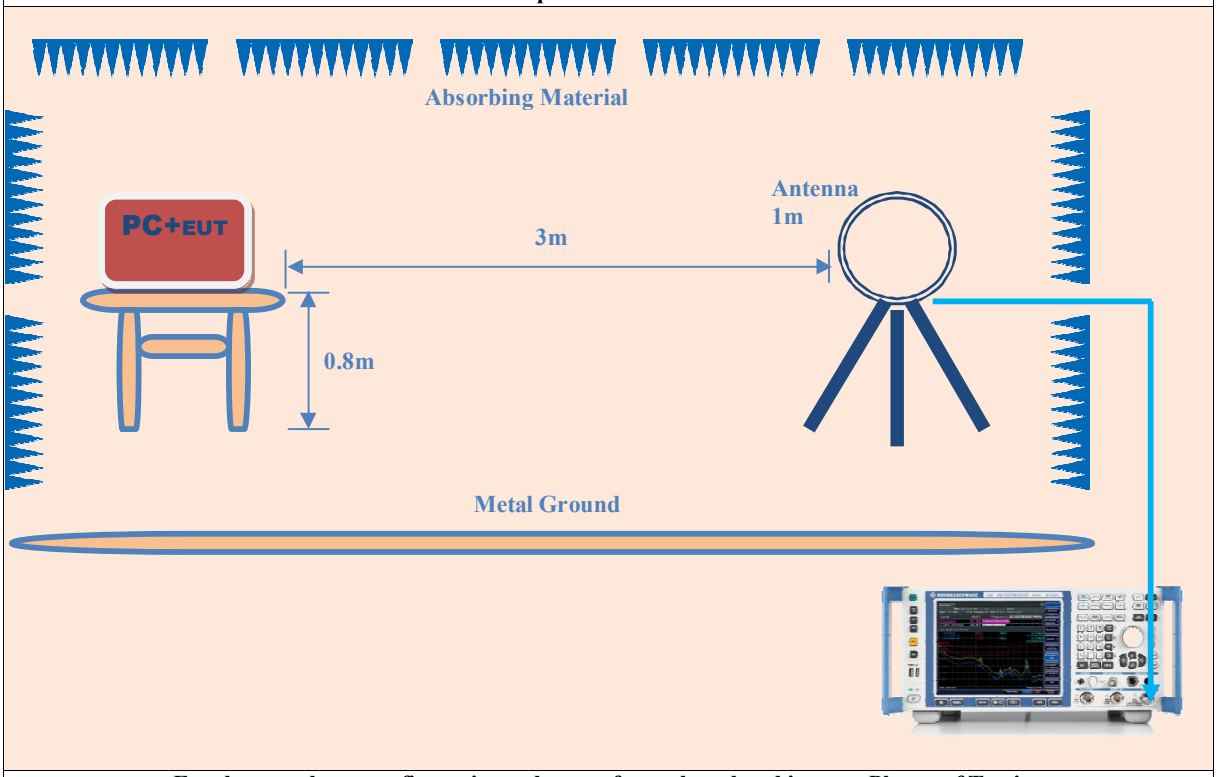
Please refer to Section 10 this report.

6. 2 Test Procedure

1. The EUT was tested according to ANSI C63.10:2013.
2. The EUT, peripherals were put on the turntable which table size is 1m x 1.5 m, table high 0.8m. All set up is according to ANSI C63.10:2013.
3. The frequency spectrum from 9kHz to 25 GHz was investigated. All readings from 9kHz to 150kHz are quasi-peak values with a resolution bandwidth of 200 Hz. All readings from 150kHz to 30MHz are quasi-peak values with a resolution bandwidth of 9 KHz. All readings from 30 MHz to 1 GHz are quasi-peak values with a resolution bandwidth of 120 KHz Measurements were made at 3 meters. All readings are above 1 GHz , peak values with a resolution bandwidth of 1 MHz . Measurements were made at 3 meters.
4. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. The Receiving antenna high is varied from 1 m to 4 m high to find the maximum emission for each frequency. Emissions below 30MHz were measured with a loop antenna while emission above 30MHz were measured using a broadband E-field antenna.
5. Maximizing procedure was performed on the six (6) highest emissions to ensure EUT compliance is with all installation combinations. All data was recorded in the peak detection mode. Quasi-peak readings was performed only when an emission was found to be marginal (within -4 dB of specification limit), and are distinguished with a "**QP**" in the data table.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter(EUT) was rotated through three orthogonal axes according to the requirements in Section 8 and 13 of ANSI C63.10:2013.

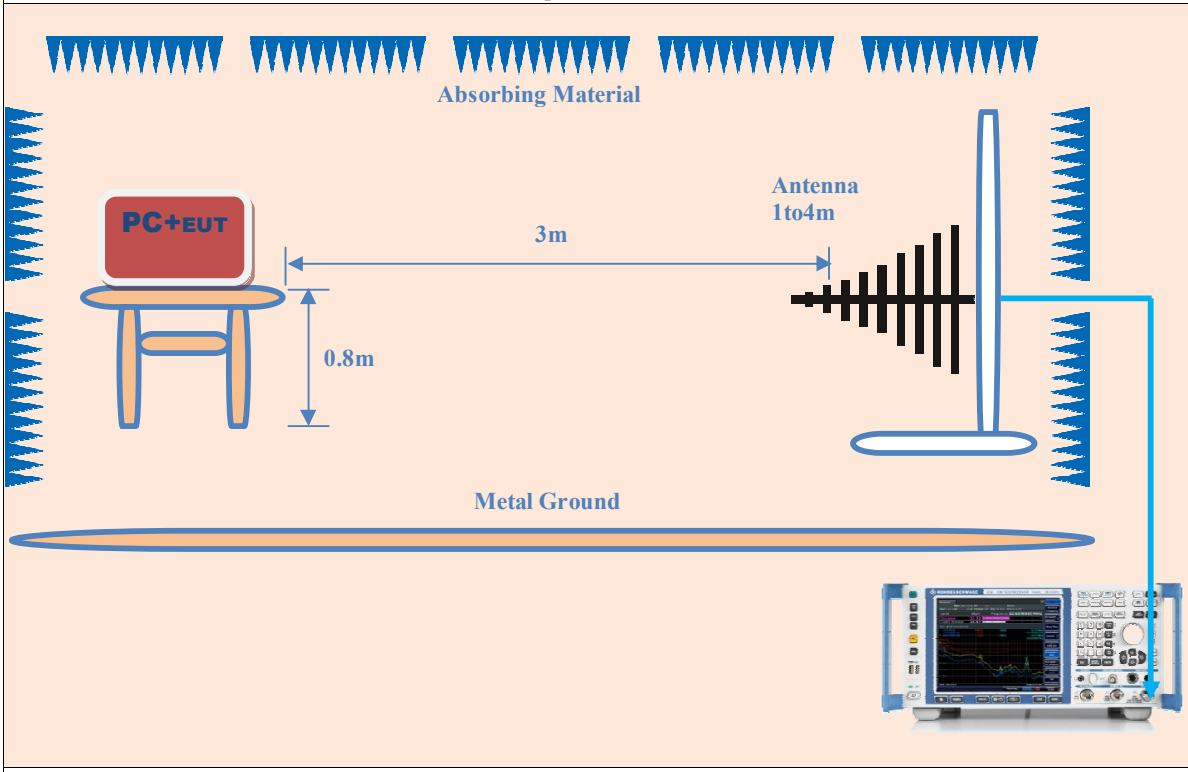
6. 3 Test Setup

For Frequencies below 30MHz



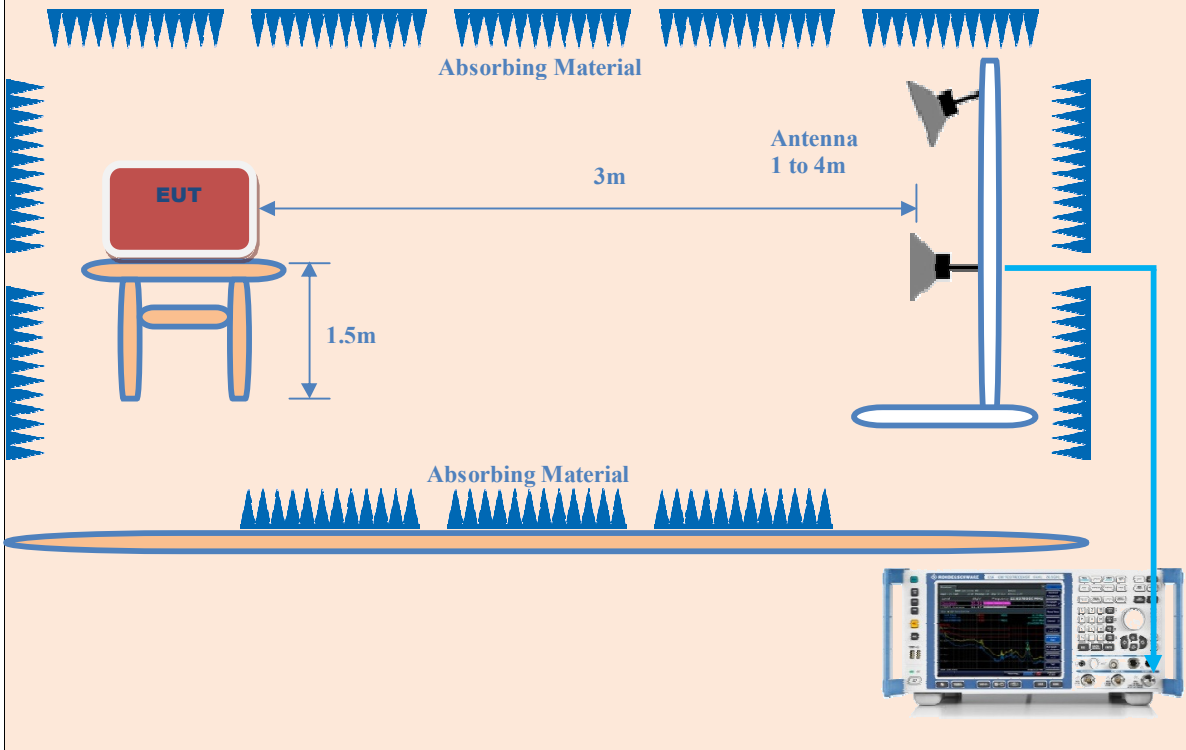
For the actual test configuration , please refer to the related items – Photos of Testing

For Frequencies below 1GHz



For the actual test configuration , please refer to the related items – Photos of Testing

For Frequencies above 1GHz



For the actual test configuration , please refer to the related items – Photos of Testing

6. 4 Configuration of the EUT
Same as section 4.4 of this report

6. 5 EUT Operating Condition
Same as section 4.5 of this report.

6. 6 Limit
In any 100 KHz bandwidth outside the operating frequency band, the radio frequency power that is produced bymodulation products of the spreading sequence, the information sequence and the carrier frequency shall beeither at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of thedesired power or shall not exceed the general levels specified in section 15.209(a), which lesser attenuation.

All other emissions inside restricted bands specified in section 15.205(a) shall not exceed the general radiatedemission limits specified in section 15.209(a)

Note:
Applies to harmonics/spurious emissions that fall in the restricted bands listed in section 15.205.Themaximum permitted average field strength is listed in section 15.209.

47 CFR §15.237(c): The emission limits as specified above are based on measurement instrumentemploying an average detector. The provisions in section 15.35 for limiting peak emissions apply.

FCC CFR 47, Part 15, Subpart C, Para, 15.205(a) – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1]0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	[2]
13.36–13.41.			

[1]UntilFebruary1,1999,thisrestrictedbandshallbe0.490–0.510MHz.
[2]Above38.6

FCC 47 CFR, Part 15.209(a) – Field Strength Limits within Restricted Frequency Bands

Frequency(MHz)	Fieldstrength (microvolts/meter)	Measure-mentdis-tance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100**	3
88–216	150**	3
216–960	200**	3
Above960	500	3

6. 7 Test Result

Test Mode 1										
Restricted Frequency Bands Data_BT LE / 1Mbps GFSKCH Low										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
2385.820	35.16	21.19	13.10	48.26	34.29	Horiz./	74.0	54.0	-25.74	-19.71
2483.210	36.24	22.77	13.10	49.34	35.87	Horiz./	74.0	54.0	-24.66	-18.13
Restricted Frequency Bands Data_BT LE / 1Mbps GFSK CH High										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
2384.690	36.17	22.55	13.10	49.27	35.65	Horiz./	74.0	54.0	-24.73	-18.35
2484.310	36.59	22.98	13.10	49.69	36.08	Horiz./	74.0	54.0	-24.31	-17.92

Test Mode 2										
Restricted Frequency Bands Data_BT LE / 1Mbps GFSKCH Low										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
2383.620	51.60	38.02	-1.34	50.26	36.68	Vert.	74.0	54.0	-23.74	-17.32
2432.500	36.85	23.75	13.10	49.95	36.85	Vert.	74.0	54.0	-24.05	-17.15
Restricted Frequency Bands Data_BT LE / 1Mbps GFSK CH High										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
2382.710	38.24	24.42	13.10	51.34	37.52	Vert.	74.0	54.0	-22.66	-16.48
2481.380	38.58	25.41	13.10	51.68	38.51	Vert.	74.0	54.0	-22.32	-15.49

Test Mode 3										
Restricted Frequency Bands Data_BT LE / 1Mbps GFSKCH Low										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
2387.650	35.48	21.88	13.10	48.58	34.98	Horiz./	74.0	54.0	-25.42	-19.02
2484.280	35.86	23.02	13.10	48.96	36.12	Horiz./	74.0	54.0	-25.04	-17.88
Restricted Frequency Bands Data_BT LE / 1Mbps GFSK CH High										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
2386.400	36.52	22.36	13.10	49.62	35.46	Horiz./	74.0	54.0	-24.38	-18.54
2482.600	36.79	23.82	13.10	49.89	36.92	Horiz./	74.0	54.0	-24.11	-17.08

Test Mode 1										
Harmonics Radiated Emission Data_BT LE / 1Mbps GFSK CH Low										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
4804.200	29.22	16.79	13.10	42.32	29.89	Horiz./	74.0	54.0	-31.68	-24.11
4804.200	28.58	15.83	13.10	41.68	28.93	Vert.	74.0	54.0	-32.32	-25.07
7206.100	28.79	16.58	13.10	41.89	29.68	Horiz./	74.0	54.0	-32.11	-24.32
7206.100	28.44	16.21	13.10	41.54	29.31	Vert.	74.0	54.0	-32.46	-24.69
24020.00	-	-	-	-	-	-	-	-	-	-
24020.00	-	-	-	-	-	-	-	-	-	-
Harmonics Radiated Emission Data_BT LE / 1Mbps GFSK CH Mid										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
4880.200	28.59	16.14	13.10	41.69	29.24	Horiz./	74.0	54.0	-32.31	-24.76
4880.200	28.11	15.55	13.10	41.21	28.65	Vert.	74.0	54.0	-32.79	-25.35
7320.300	27.46	16.14	13.10	40.56	29.24	Horiz./	74.0	54.0	-33.44	-24.76
7320.300	27.58	16.32	13.10	40.68	29.42	Vert.	74.0	54.0	-33.32	-24.58
24400.00	-	-	-	-	-	-	-	-	-	-
24400.00	-	-	-	-	-	-	-	-	-	-
Harmonics Radiated Emission Data_BT LE / 1Mbps GFSK CH High										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
4960.100	28.13	16.58	13.10	41.23	29.68	Horiz./	74.0	54.0	-32.77	-24.32
4960.100	28.28	16.64	13.10	41.38	29.74	Vert.	74.0	54.0	-32.62	-24.26
7440.200	28.19	16.54	13.10	41.29	29.64	Horiz./	74.0	54.0	-32.71	-24.36
7440.200	28.27	16.66	13.10	41.37	29.76	Vert.	74.0	54.0	-32.63	-24.24
24800.00	-	-	-	-	-	-	-	-	-	-
24800.00	-	-	-	-	-	-	-	-	-	-

Note: (1) All Reading Levels below 1GHz are Quasi-Peak, above are peak and average value.
(2) Emission Level = Reading Level + Probe Factor + Cable Loss.
(3) Span shall wide enough to fully capture theemission being measured;
Set RBW = 1 MHz, VBW= 3MHz for f > 1 GHzfor peak measurement.
For average measurement: VBW = 10 Hz, whenduty cycle is no less than 98 percent. VBW ⩾ 1/T,when duty cycle is less than 98 percent where T isthe minimum transmission duration over which thetransmitter is on and is transmitting at its maximumpower control level for the tested mode of operation.
(4) The average measurement was not performed when the peak measured data under the limit of average detection. If the readings given are average, peak measurement should also be supplied.
(5)Where an emission level is indicated by a –, levels had a margin greater than 20 dBwhen compared to the limit.

Test Mode 2										
Harmonics Radiated Emission Data_BT LE / 1Mbps GFSK CH Low										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
4804.200	30.52	19.83	13.10	43.62	32.93	Horiz./	74.0	54.0	-30.38	-21.07
4804.200	31.11	20.05	13.10	44.21	33.15	Vert.	74.0	54.0	-29.79	-20.85
7206.100	30.82	19.68	13.10	43.92	32.78	Horiz./	74.0	54.0	-30.08	-21.22
7206.100	31.25	19.59	13.10	44.35	32.69	Vert.	74.0	54.0	-29.65	-21.31
24020.00	-	-	-	-	-	-	-	-	-	-
24020.00	-	-	-	-	-	-	-	-	-	-
Harmonics Radiated Emission Data_BT LE / 1Mbps GFSK CH Mid										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
4880.200	29.88	19.55	13.10	42.98	32.65	Horiz./	74.0	54.0	-31.02	-21.35
4880.200	29.55	20.48	13.10	42.65	33.58	Vert.	74.0	54.0	-31.35	-20.42
7320.300	29.58	20.52	13.10	42.68	33.62	Horiz./	74.0	54.0	-31.32	-20.38
7320.300	29.62	19.85	13.10	42.72	32.95	Vert.	74.0	54.0	-31.28	-21.05
24400.00	-	-	-	-	-	-	-	-	-	-
24400.00	-	-	-	-	-	-	-	-	-	-
Harmonics Radiated Emission Data_BT LE / 1Mbps GFSK CH High										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
4960.100	30.22	20.18	13.10	43.32	33.28	Horiz./	74.0	54.0	-30.68	-20.72
4960.100	31.09	20.51	13.10	44.19	33.61	Vert.	74.0	54.0	-29.81	-20.39
7440.200	30.59	19.77	13.10	43.69	32.87	Horiz./	74.0	54.0	-30.31	-21.13
7440.200	30.18	19.99	13.10	43.28	33.09	Vert.	74.0	54.0	-30.72	-20.91
24800.00	-	-	-	-	-	-	-	-	-	-
24800.00	-	-	-	-	-	-	-	-	-	-

Note: (1) All Reading Levels below 1GHz are Quasi-Peak, above are peak and average value.
(2) Emission Level = Reading Level + Probe Factor + Cable Loss.
(3) Span shall wide enough to fully capture theemission being measured;
Set RBW = 1 MHz, VBW= 3MHz for f > 1 GHzfor peak measurement.
For average measurement: VBW = 10 Hz, whenduty cycle is no less than 98 percent. VBW ⩾ 1/T,when duty cycle is less than 98 percent where T isthe minimum transmission duration over which thetransmitter is on and is transmitting at its maximumpower control level for the tested mode of operation.
(4) The average measurement was not performed when the peak measured data under the limit of average detection. If the readings given are average, peak measurement should also be supplied.
(5)Where an emission level is indicated by a –, levels had a margin greater than 20 dBwhen compared to the limit.

Test Mode 3										
Harmonics Radiated Emission Data_BT LE / 1Mbps GFSK CH Low										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
4804.200	28.22	19.17	13.10	41.32	32.27	Horiz./	74.0	54.0	-32.68	-21.73
4804.200	29.03	19.74	13.10	42.13	32.84	Vert.	74.0	54.0	-31.87	-21.16
7206.100	29.09	18.18	13.10	42.19	31.28	Horiz./	74.0	54.0	-31.81	-22.72
7206.100	27.82	18.97	13.10	40.92	32.07	Vert.	74.0	54.0	-33.08	-21.93
24020.00	-	-	-	-	-	-	-	-	-	-
24020.00	-	-	-	-	-	-	-	-	-	-
Harmonics Radiated Emission Data_BT LE / 1Mbps GFSK CH Mid										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
4880.200	28.18	17.86	13.10	41.28	30.96	Horiz./	74.0	54.0	-32.72	-23.04
4880.200	28.26	18.44	13.10	41.36	31.54	Vert.	74.0	54.0	-32.64	-22.46
7320.300	29.23	17.52	13.10	42.33	30.62	Horiz./	74.0	54.0	-31.67	-23.38
7320.300	29.91	17.93	13.10	43.01	31.03	Vert.	74.0	54.0	-30.99	-22.97
24400.00	-	-	-	-	-	-	-	-	-	-
24400.00	-	-	-	-	-	-	-	-	-	-
Harmonics Radiated Emission Data_BT LE / 1Mbps GFSK CH High										
Frequency (MHz)	Read Level (dBuV) PK	Read Level (dBuV) AV	Factor (dB)	Emission (dBuV/m) PK	Emission (dBuV/m) AV	Horiz./ Vert.	Limit (dBuV/m) PK	Limit (dBuV/m) AV	Margin(dB) PK	Margin(dB) AV
4960.100	28.29	17.52	13.10	41.39	30.62	Horiz./	74.0	54.0	-32.61	-23.38
4960.100	28.55	17.69	13.10	41.65	30.79	Vert.	74.0	54.0	-32.35	-23.21
7440.200	28.96	17.97	13.10	42.06	31.07	Horiz./	74.0	54.0	-31.94	-22.93
7440.200	29.92	18.78	13.10	43.02	31.88	Vert.	74.0	54.0	-30.98	-22.12
24800.00	-	-	-	-	-	-	-	-	-	-
24800.00	-	-	-	-	-	-	-	-	-	-

Note: (1) All Reading Levels below 1GHz are Quasi-Peak, above are peak and average value.
(2) Emission Level = Reading Level + Probe Factor + Cable Loss.
(3) Span shall wide enough to fully capture theemission being measured;
Set RBW = 1 MHz, VBW= 3MHz for f > 1 GHzfor peak measurement.
For average measurement: VBW = 10 Hz, whenduty cycle is no less than 98 percent. VBW ⩾ 1/T,when duty cycle is less than 98 percent where T isthe minimum transmission duration over which thetransmitter is on and is transmitting at its maximumpower control level for the tested mode of operation.
(4) The average measurement was not performed when the peak measured data under the limit of average detection. If the readings given are average, peak measurement should also be supplied.
(5)Where an emission level is indicated by a –, levels had a margin greater than 20 dBwhen compared to the limit.

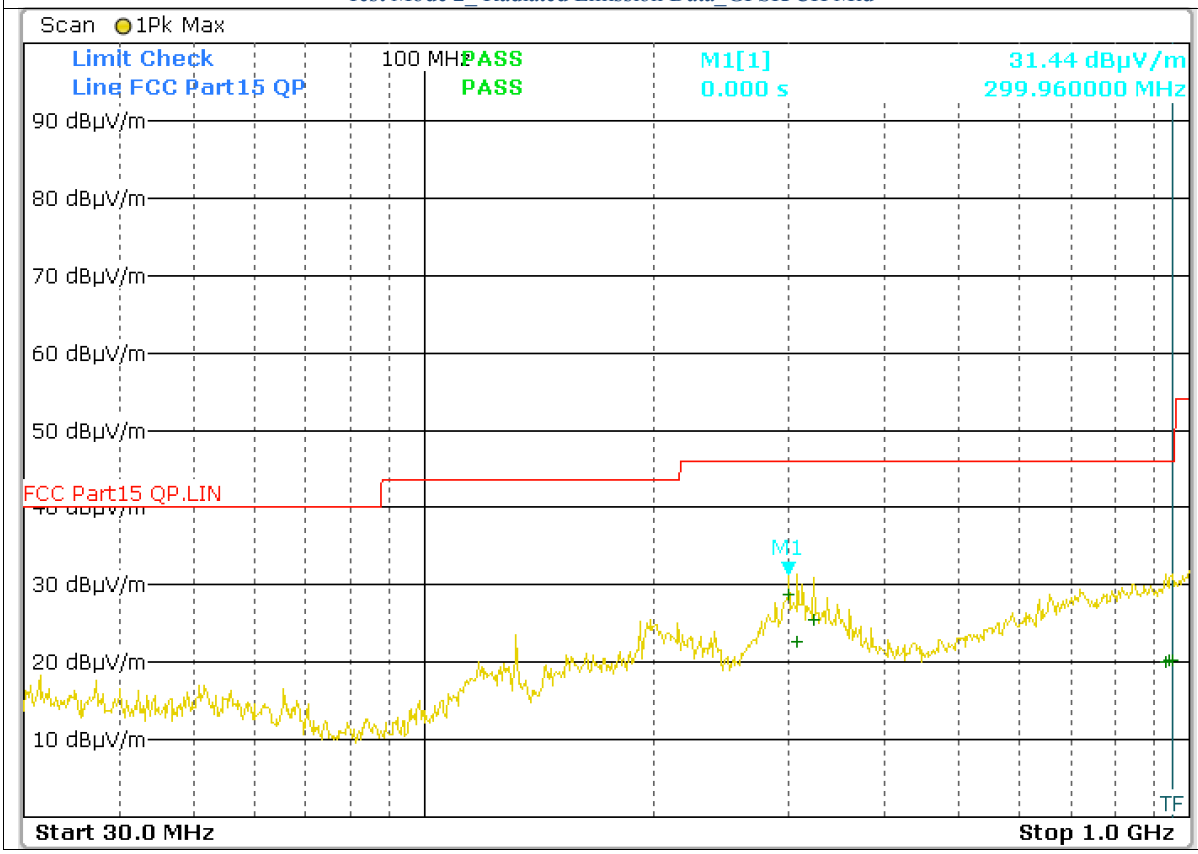
General Radiated Emission Data
For Frequency below 30MHz

Frequency (MHz)	Read Level (dBuV)	Factor (dB)	Emission (dBuV/m)	Horiz./ Vert.	Limit (dBuV/m)	Margin (dB)
N/A						
N/A						
N/A						
N/A						
N/A						
N/A						

Note: (1) All Readings below 1GHz are Quasi-Peak, above are performed with peak and/or average measurements as necessary.
(2) "N/A" remark, if no specific emissions from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.
(3) Emission Level = Reading Level + Probe Factor + Cable Loss.

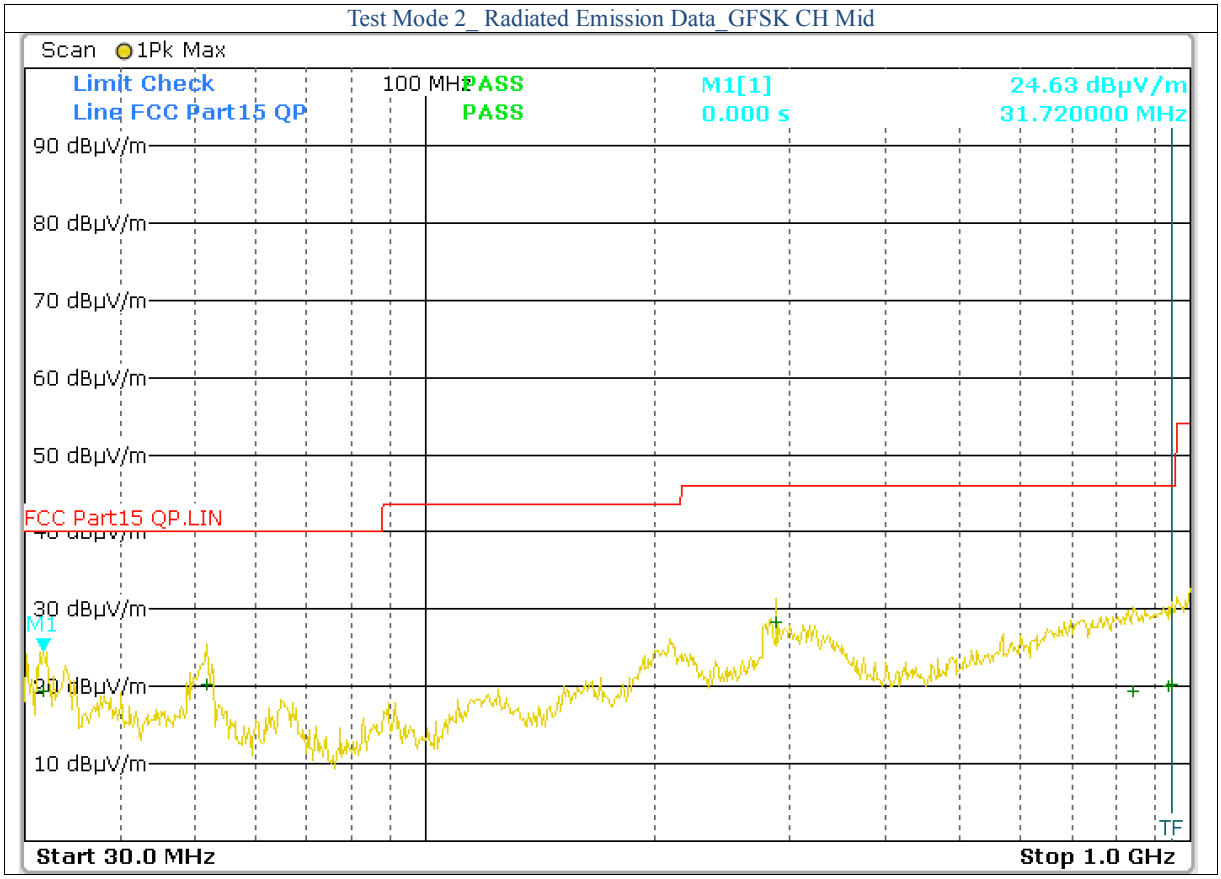
For Frequency from 30MHz to 1GHz

Test Mode 2_ Radiated Emission Data_GFSK CH Mid



Frequency (MHz)	Read Level (dBuV)	Factor (dB)	Emission (dBuV/m)	Horiz./ Vert.	Limit (dBuV/m)	Margin (dB)
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		

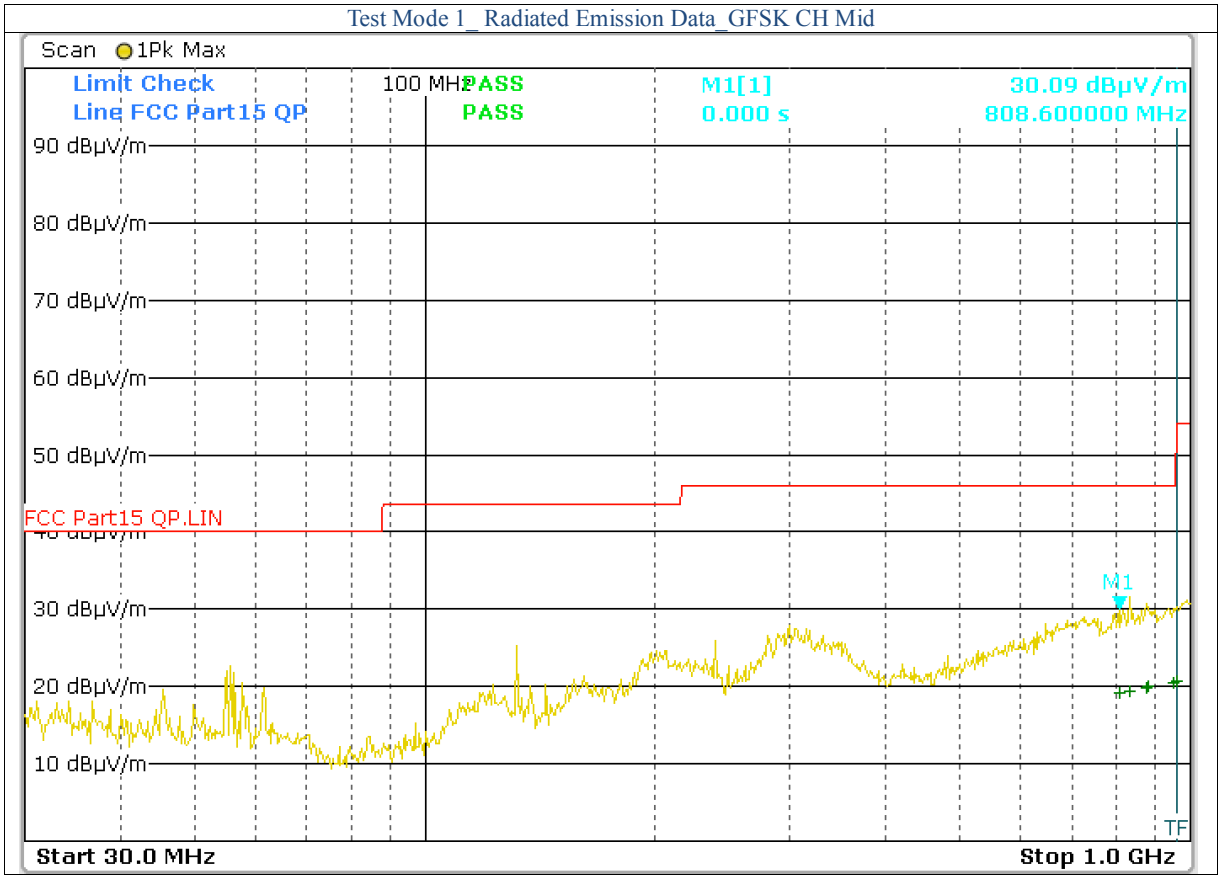
Test Mode 2_ Radiated Emission Data_GFSK CH Mid



Frequency (MHz)	Read Level (dBuV)	Factor (dB)	Emission (dBuV/m)	Horiz./ Vert.	Limit (dBuV/m)	Margin (dB)
N/A				Vert.		
N/A				Vert.		
N/A				Vert.		
N/A				Vert.		
N/A				Vert.		
N/A				Vert.		

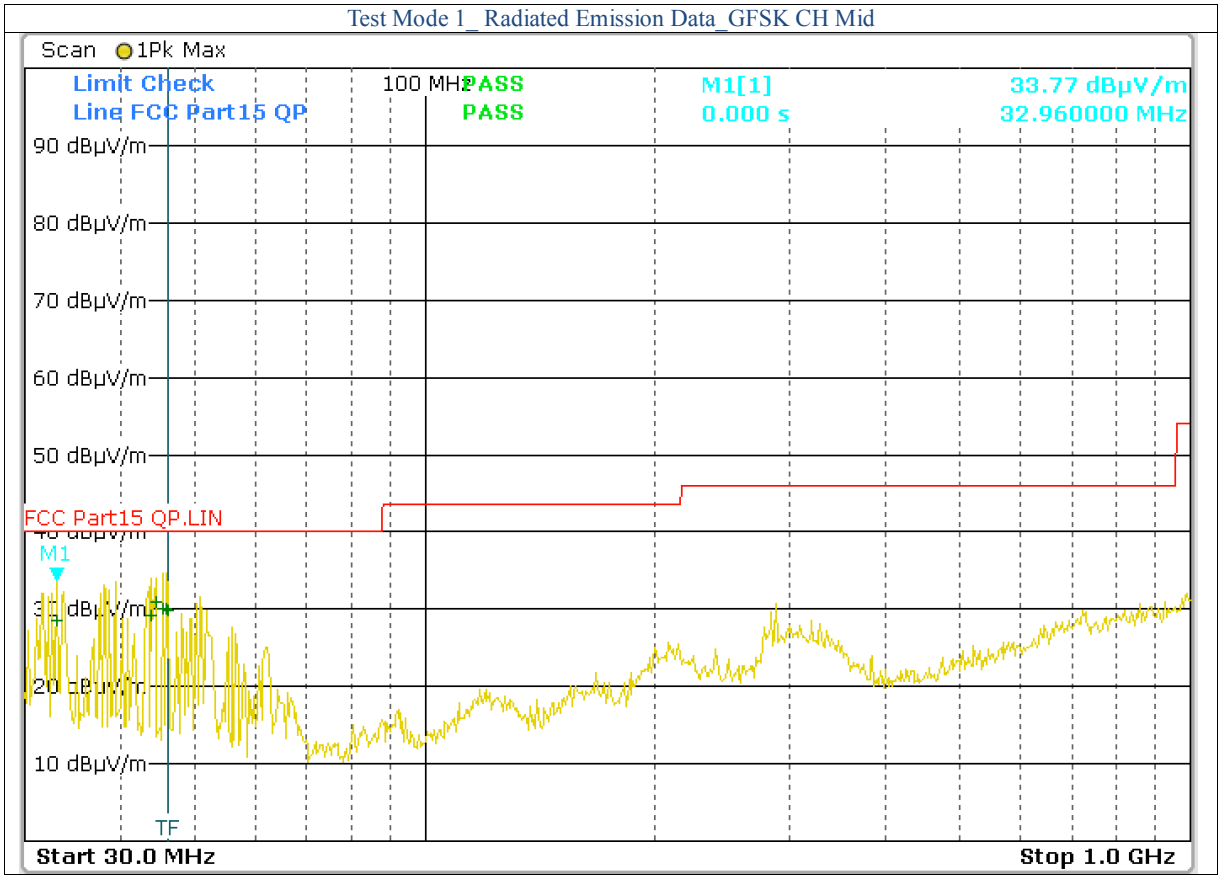
Note:
(1) All Readings below 1GHz are Quasi-Peak, above are performed with peak and/or average measurements as necessary.
(2) "N/A" remark, if no specific emissions from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.
(3) Emission Level = Reading Level + Probe Factor + Cable Loss.

Test Mode 1_ Radiated Emission Data_GFSK CH Mid



Frequency (MHz)	Read Level (dBuV)	Factor (dB)	Emission (dBuV/m)	Horiz./ Vert.	Limit (dBuV/m)	Margin (dB)
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		

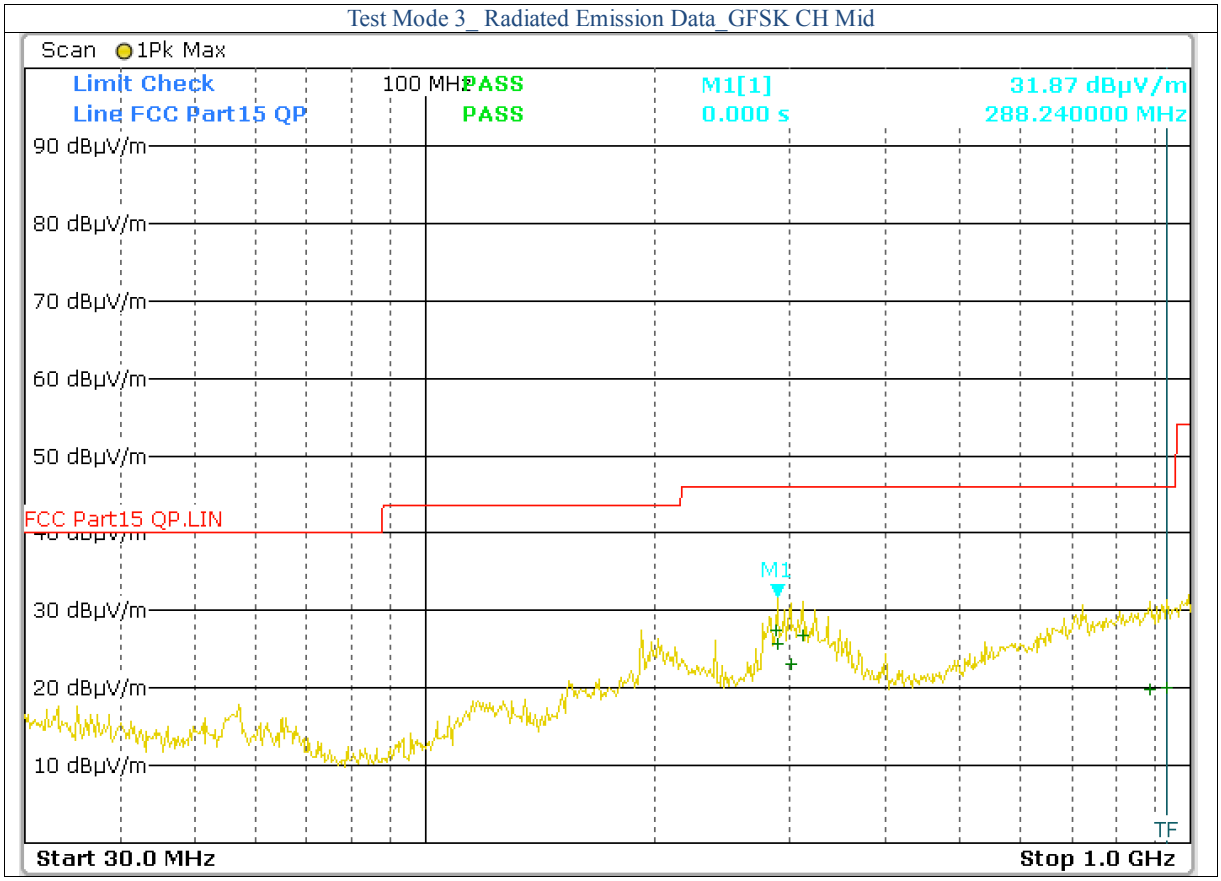
Test Mode 1_ Radiated Emission Data_GFSK CH Mid



Frequency (MHz)	Read Level (dBuV)	Factor (dB)	Emission (dBuV/m)	Horiz./ Vert.	Limit (dBuV/m)	Margin (dB)
32.960	17.94	10.66	28.60	Vert.	40.0	-11.40
43.960	18.54	10.66	29.20	Vert.	40.0	-10.80
44.480	20.34	10.66	31.00	Vert.	40.0	-9.00
45.520	21.21	8.81	30.02	Vert.	40.0	-9.98
45.960	21.24	8.81	30.05	Vert.	40.0	-9.95
46.040	20.97	8.81	29.78	Vert.	40.0	-10.22

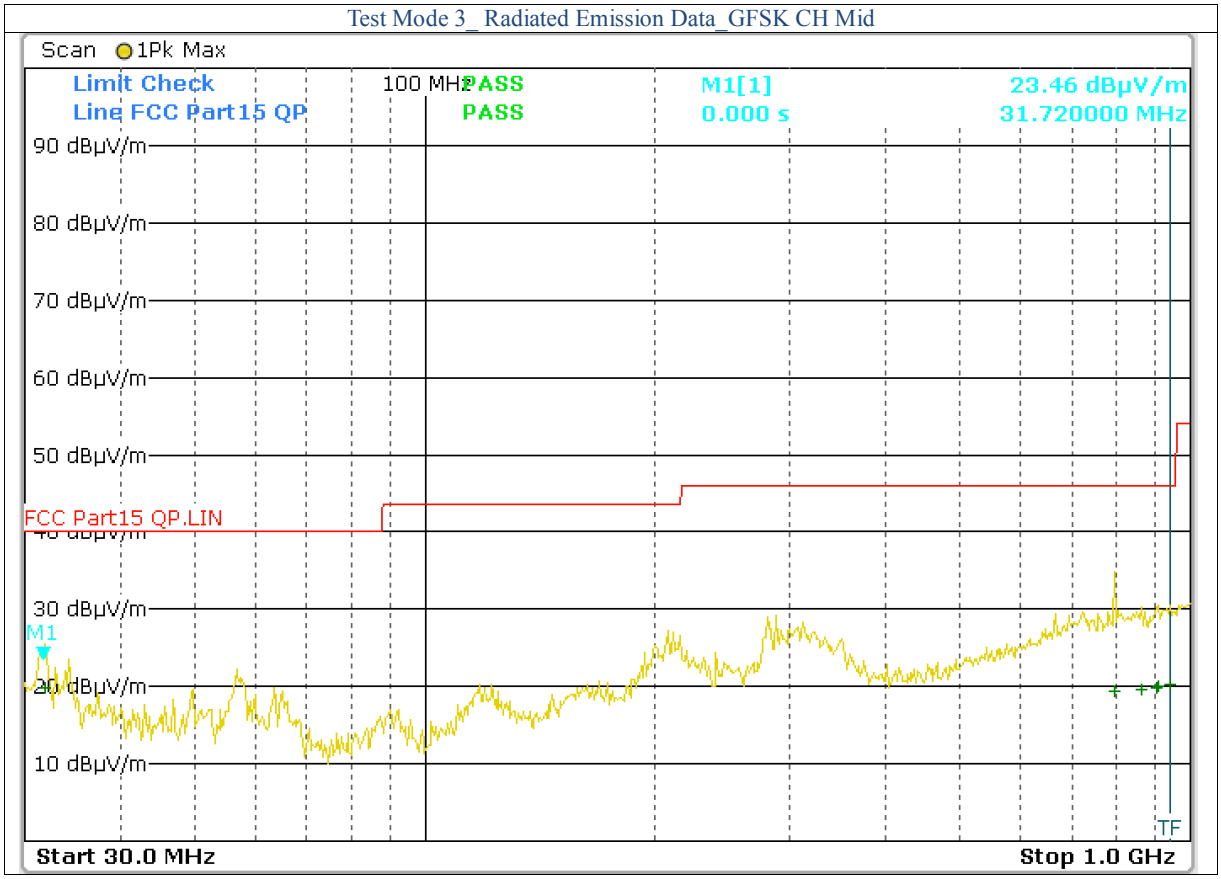
Note:
(4) All Readings below 1GHz are Quasi-Peak, above are performed with peak and/or average measurements as necessary.
(5) "N/A" remark, if no specific emissions from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.
(6) Emission Level = Reading Level + Probe Factor + Cable Loss.

Test Mode 3_ Radiated Emission Data_GFSK CH Mid



Frequency (MHz)	Read Level (dBuV)	Factor (dB)	Emission (dBuV/m)	Horiz./ Vert.	Limit (dBuV/m)	Margin (dB)
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		
N/A				Horiz./		

Test Mode 3_ Radiated Emission Data_GFSK CH Mid



Frequency (MHz)	Read Level (dBuV)	Factor (dB)	Emission (dBuV/m)	Horiz./ Vert.	Limit (dBuV/m)	Margin (dB)
N/A				Vert.		
N/A				Vert.		
N/A				Vert.		
N/A				Vert.		
N/A				Vert.		
N/A				Vert.		

Note:
(7) All Readings below 1GHz are Quasi-Peak, above are performed with peak and/or average measurements as necessary.
(8) "N/A" remark, if no specific emissions from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.
(9) Emission Level = Reading Level + Probe Factor + Cable Loss.

7. Photos of Testing

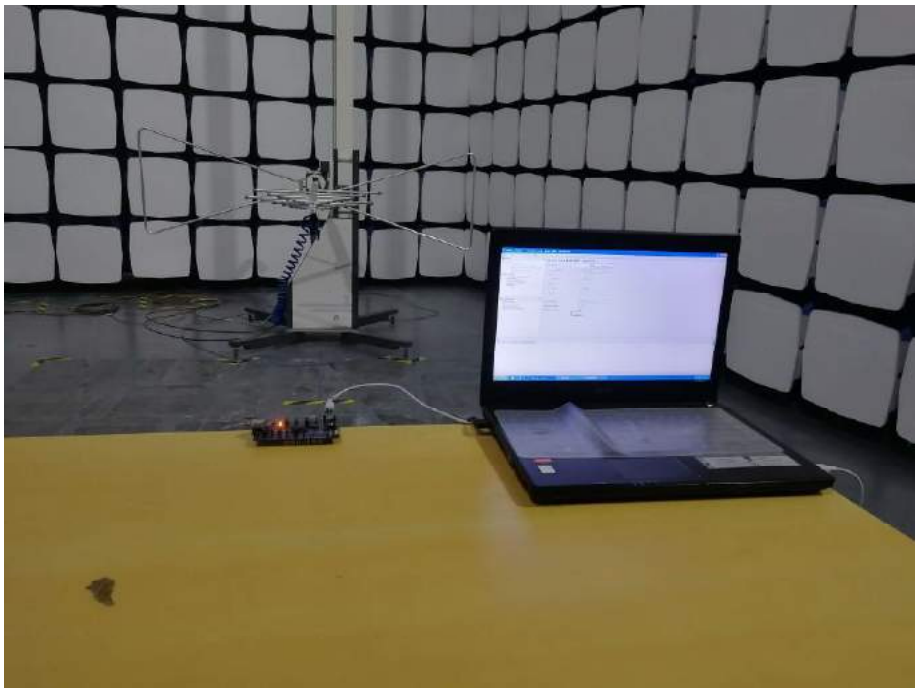
7.1 EUT Test Photographs

Test Mode_1 Conducted Emission test view_AC

Test Mode_2 Conducted Emission test view_AC

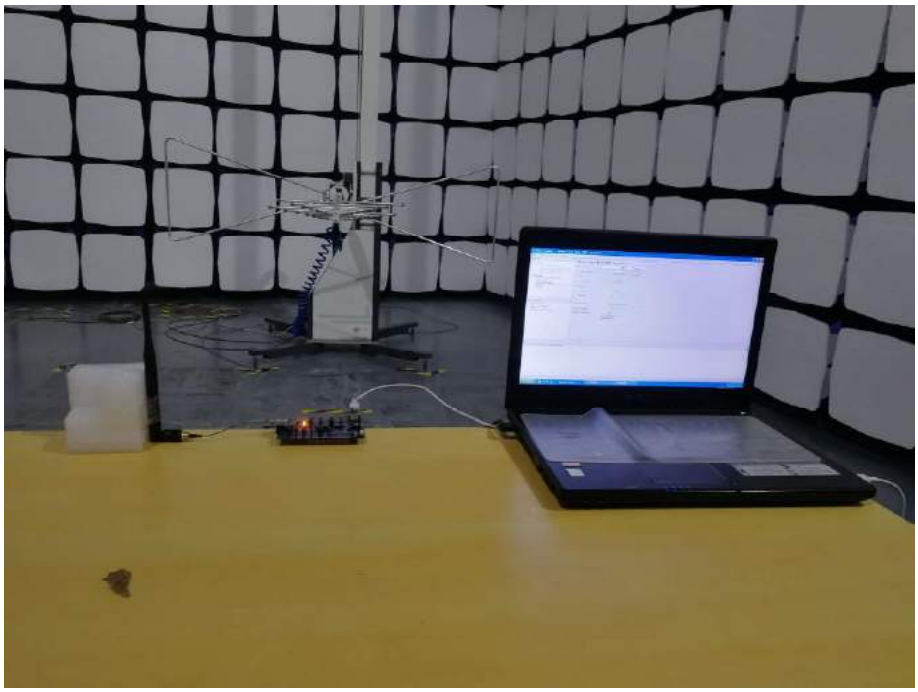

Test Mode_3 Conducted Emission test view_AC Test


Test Mode_1 - Radiated Emission test view (Frequency from 30MHz to 1GHz)



Test Mode_1 - Radiated Emission test view (Frequency above 1GHz)

Test Mode_2- Radiated Emission test view (Frequency from 30MHz to 1GHz)



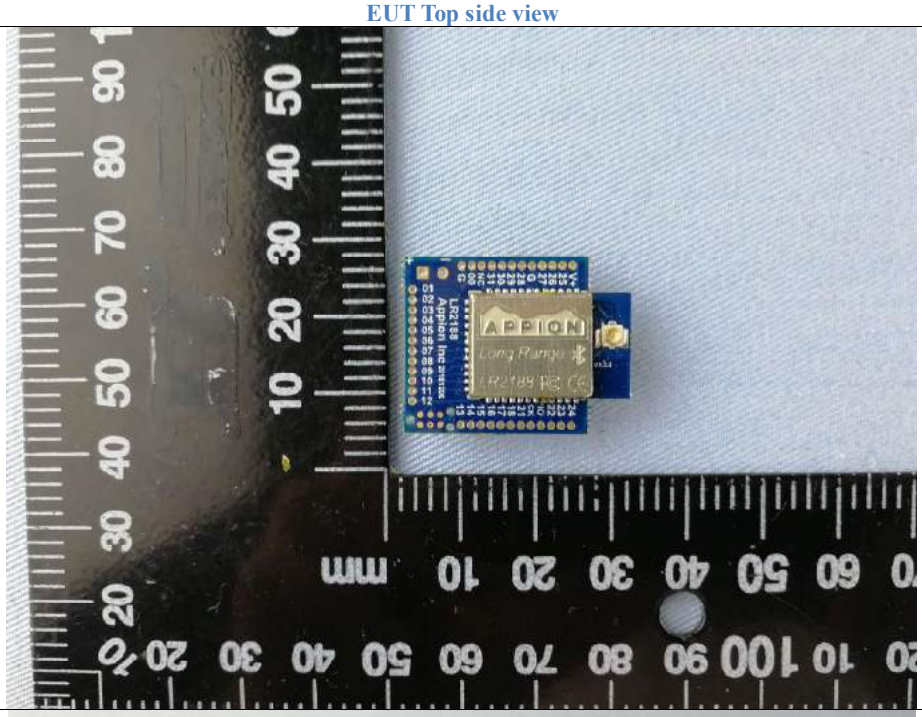
Test Mode_2 - Radiated Emission test view (Frequency above 1GHz)

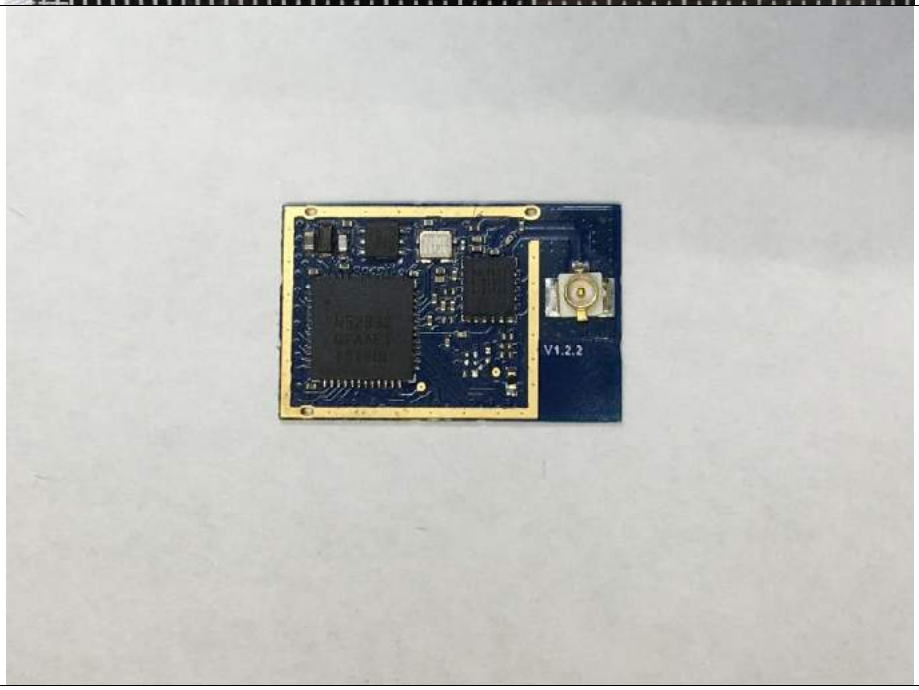
Test Mode_3 - Radiated Emission test view (Frequency from 30MHz to 1GHz)

Test Mode_3 - Radiated Emission test view (Frequency above 1GHz)

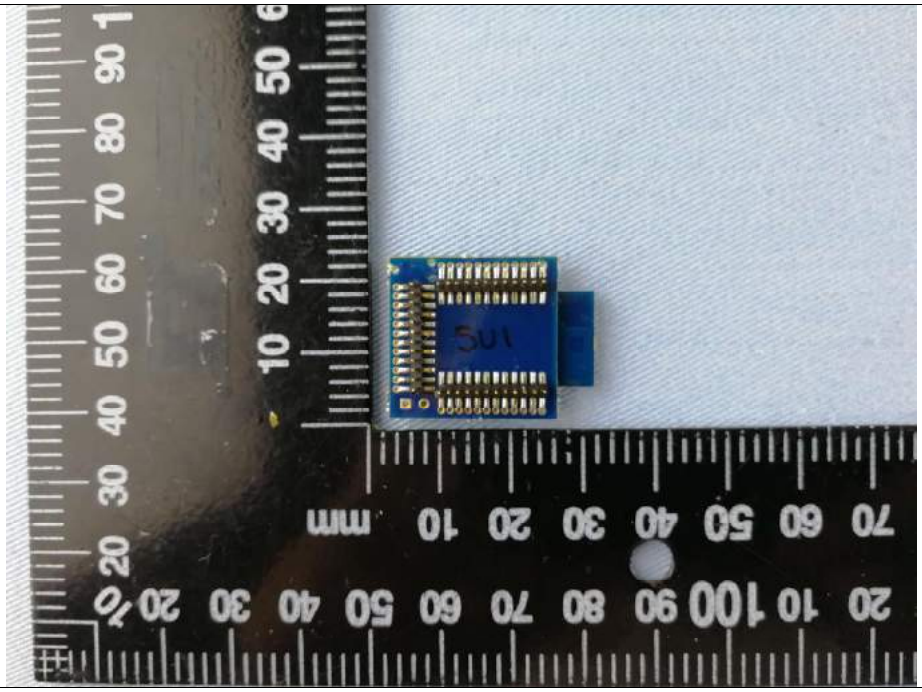
8. Photographs – EUT

EUT Top side view

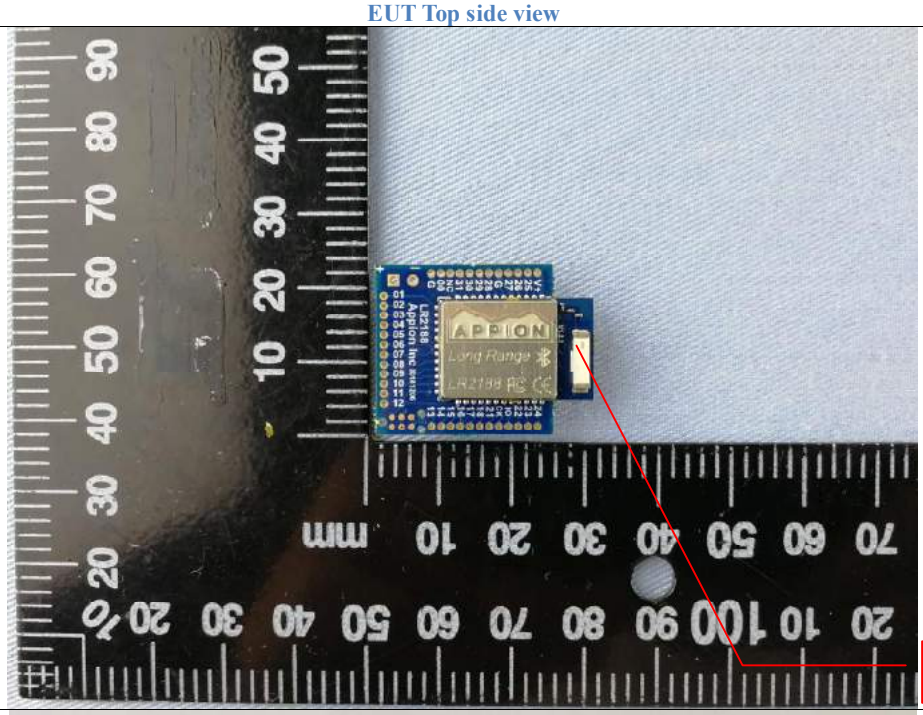


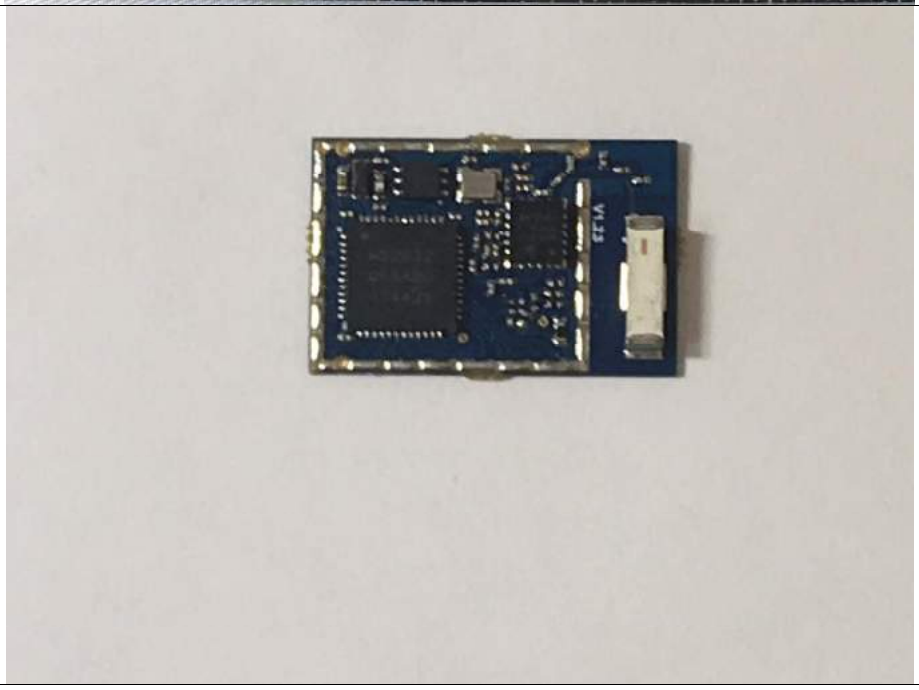


EUT bottom side view

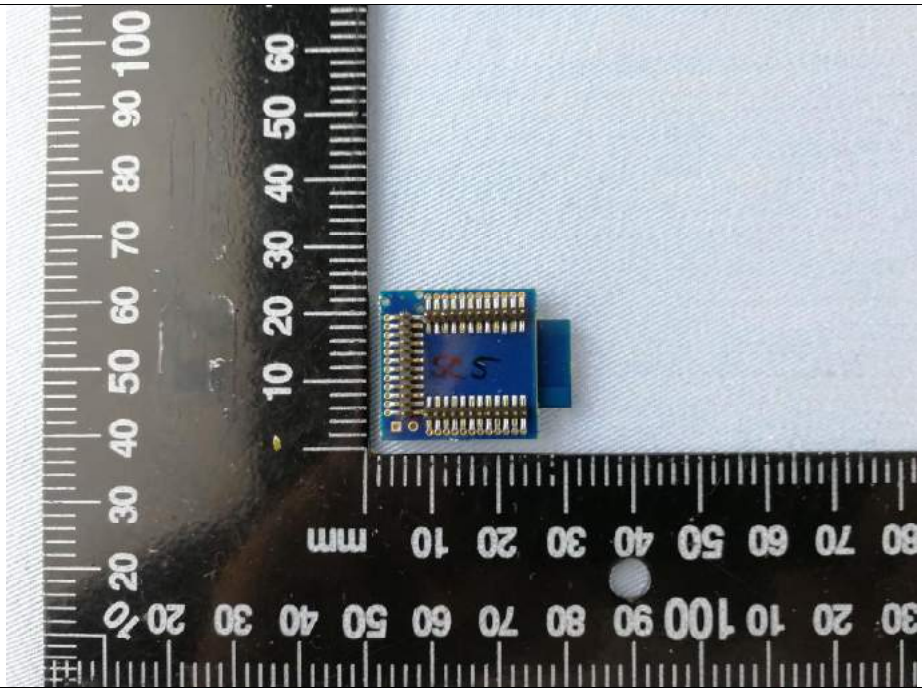


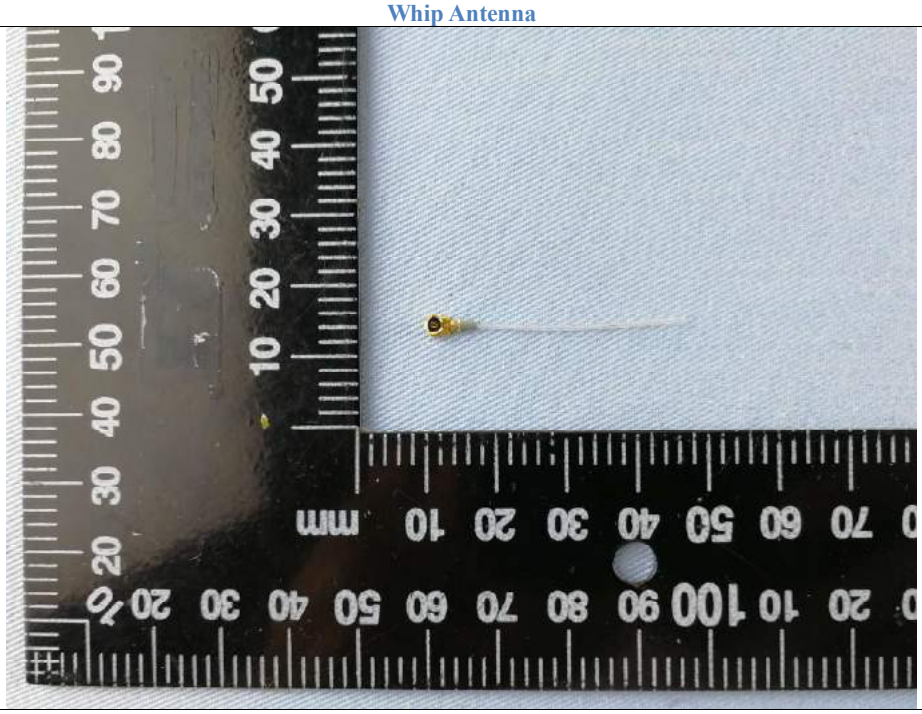
EUT Top side view



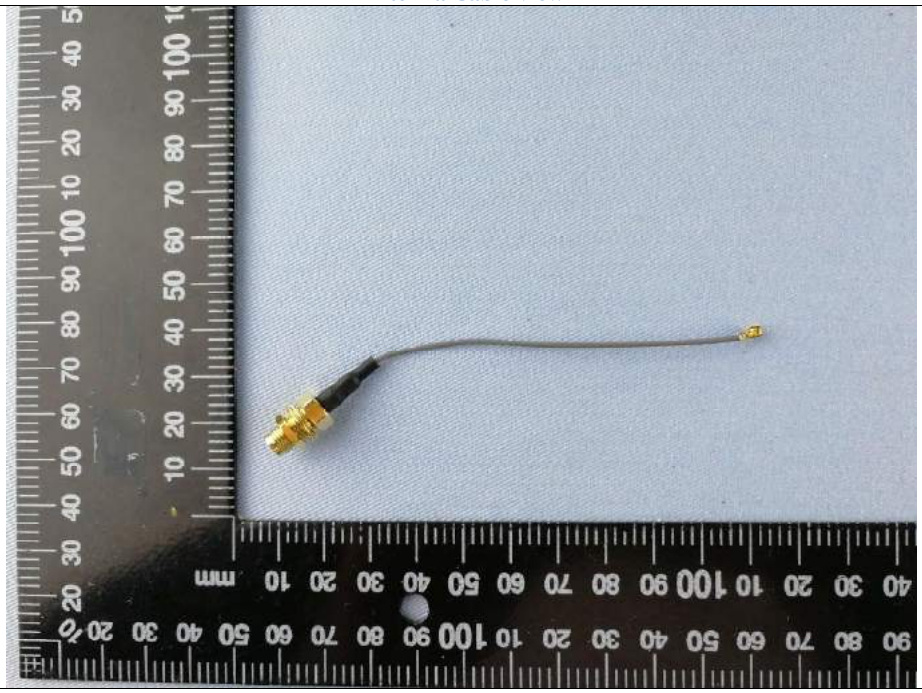


EUT bottom side view

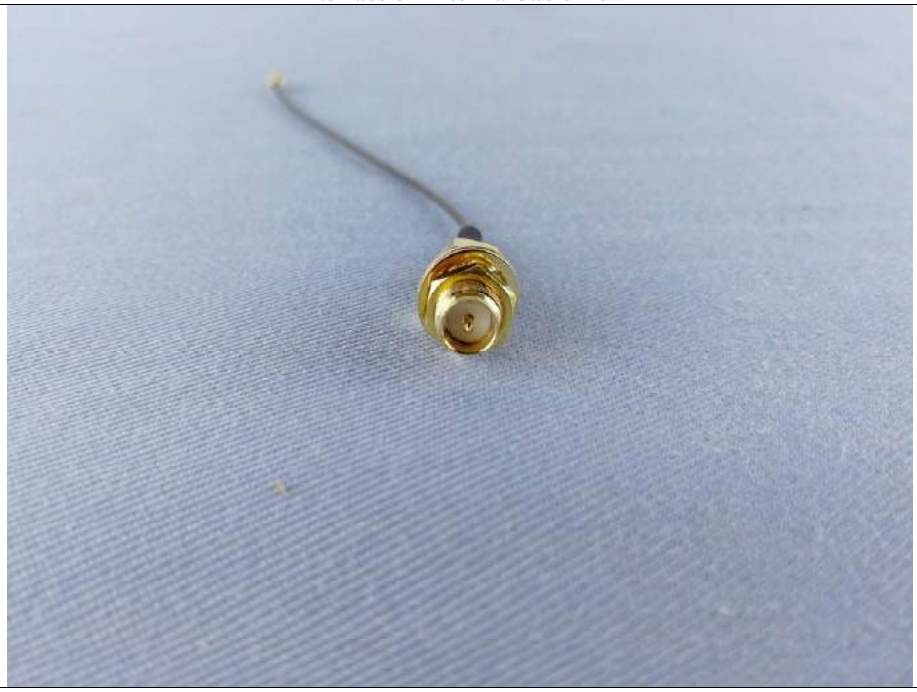


Whip Antenna

Dipole Antenna

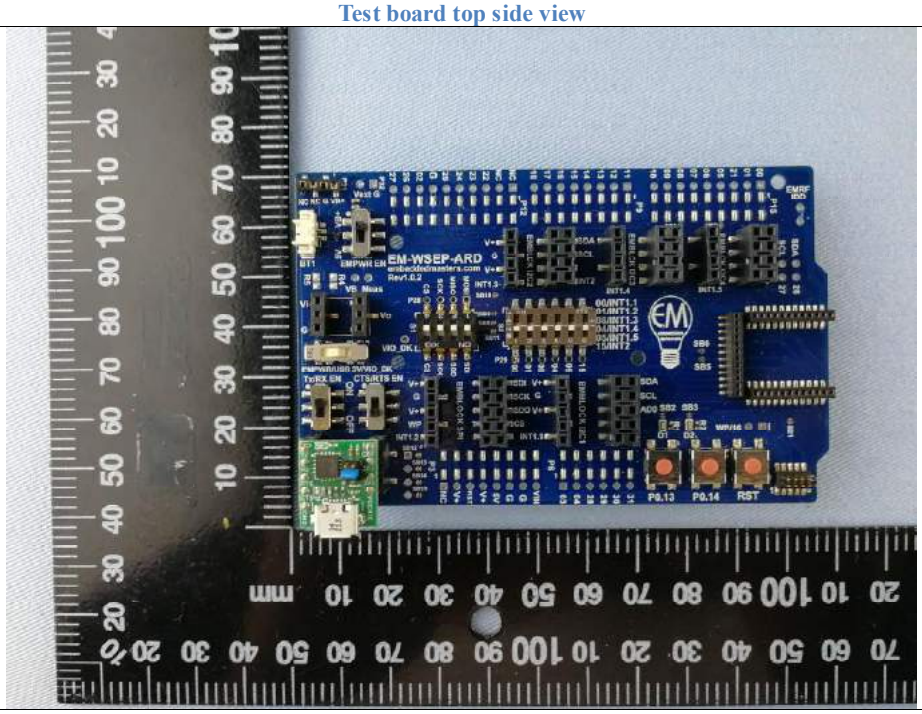

Antenna Cable view



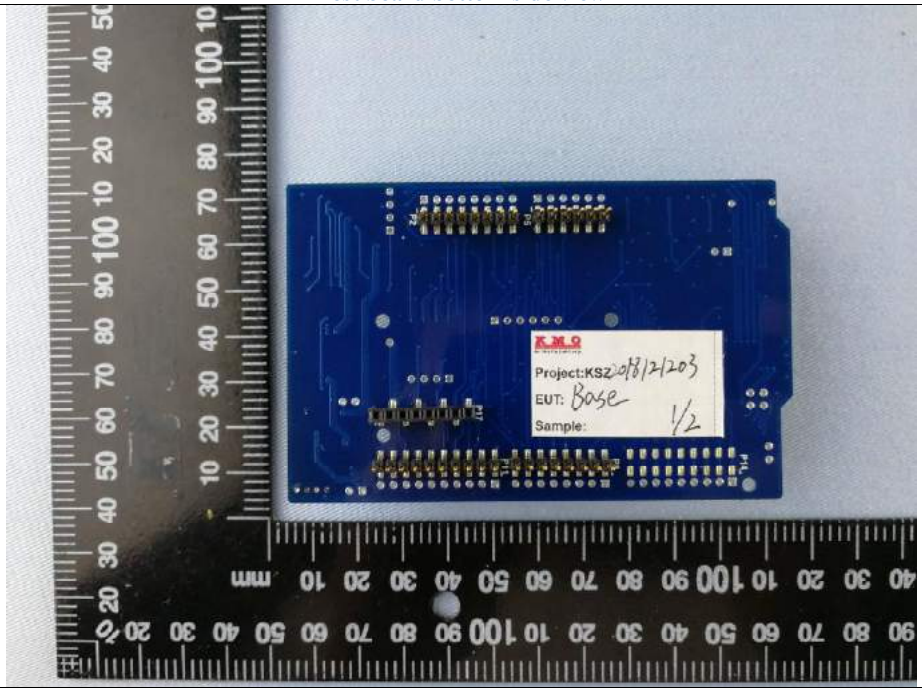
Interface of Antenna Cable view



Test board top side view



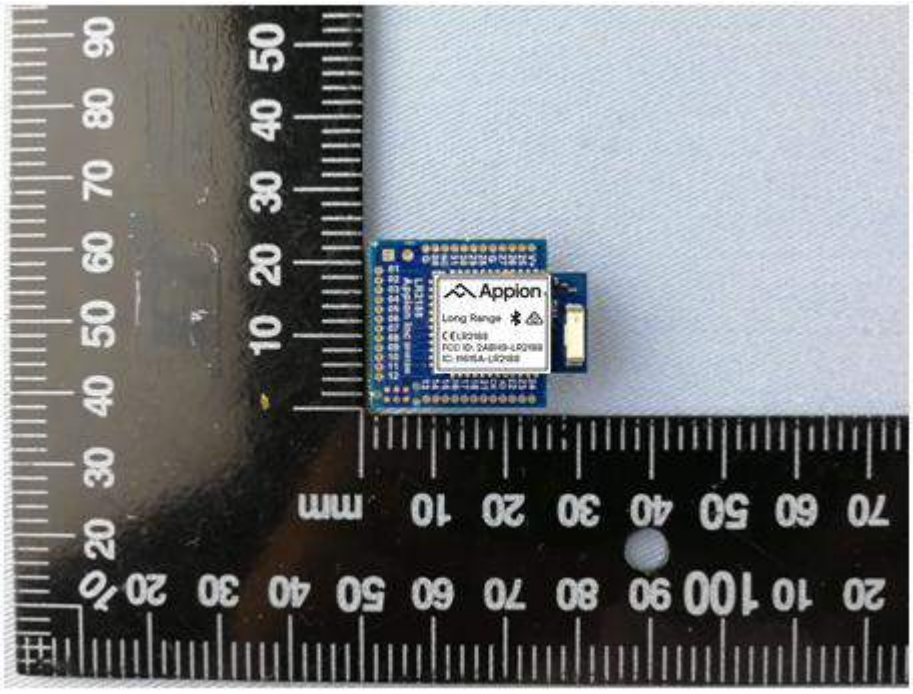
Test board bottom side view



9. FCC ID Label

The following note shall be conspicuously placed in the user manual: "**Operation is subject to the following two conditions: (1) this device may not cause interference, and(2) this device must accept any interference, including interference that may cause undesired operation of this device.**"

The Label must not be a stick-on paper label. The Label on these products must be permanently affixed to the product and readily visible at the time of purchase and must last the expected lifetime of the equipment not be readily detachable.

Proposed Label Location on EUT


10. Test Equipment

The following test equipments were used during the radiated & conducted emission test:

Equipment/ Facilities	Manufacturer	Model #	Serial No.	Cal/Char Date	Due Date
Turntable	Innco systems GmbH	CT-0801	N/A	NCR	NCR
Antenna Tower	Innco systems GmbH	MA-4640-XP-ET	N/A	NCR	NCR
Controller	Innco systems GmbH	CO3000	955/38850716L	NCR	NCR
Pre-Amplifier	Agilent	87405C	MY47010722	Dec.6, 2017	Dec.6, 2019
Pre-Amplifier	Com-Power	PAM-840	N/A	Dec.6, 2017	Dec.6, 2019
Horn Antenna	SCHWARZBECK	BBHA 9170	N/A	Dec.6, 2017	Dec.6, 2019
EMI Test Receiver	Rohde & Schwarz	ESR7	101091	Nov. 21, 2018	Nov. 21, 2020
Spectrum Analyzer	Rohde & Schwarz	FSP40	100273	Dec.14, 2017	Dec.14, 2019
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100022	Feb.21, 2018	Feb.21, 2020
Trilog-Super Broadband Antenna	SCHWARZBECK	VULB9161	9161-4079	Nov. 27, 2018	Nov. 27, 2021
Broad-Band Horn Antenna	SCHWARZBECK	BBHA 9120D	9120D-565	Nov. 29, 2018	Nov. 29, 2021
AMN	Rohde & Schwarz	ESH3-Z5	100197	Dec.25, 2017	Dec.25, 2020
AMN	CYBERTEK	EM5040A	E115040054	Nov. 21, 2018	Nov. 21, 2021
KMO Shielded Room	KMO	KMO-001	N/A	NCR	NCR
Coaxial Cable with N-Connectors	SCHWARZBECK	AK9515H	95549	Sep.18, 2017	Sep.18, 2019
3m Anechoic Chamber	KMO	KMO-3AC	N/A	Dec.23, 2017	Dec.23, 2019
Temperature Chamber	TABAI	PSL-4GTW	N/A	Feb.10, 2019	Feb.10, 2021

----------End of Report ----------